Evolution of nonoperatively treated symptomatic isolated full-thickness supraspinatus tears

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Abstract: BACKGROUND: The natural history of small, symptomatic rotator cuff tears is currently unclear. The purpose of the present study was to assess the clinical and structural outcomes for a consecutive series of patients with symptomatic, isolated full-thickness supraspinatus tears who had been offered rotator cuff repair but declined operative treatment. METHODS: In the study period, twenty-four patients with isolated full-thickness supraspinatus tears that had been diagnosed by means of magnetic resonance arthrography were offered rotator cuff repair and elected nonoperative treatment. The twenty men and four women had an average age of fifty-two years at the time of diagnosis. At a median of forty-two months after the diagnosis, all patients were reexamined clinically according to the Constant and Murley scoring system and all shoulders underwent standard magnetic resonance imaging. RESULTS: At the time of follow-up, the mean subjective shoulder score was 74% of that for a normal shoulder and the mean Constant score was 75 points (relative Constant score, 86%). The mean rotator cuff tear size did not change significantly over time (95% confidence interval, 0.51 to 1.12). In two shoulders, the tear was no longer detectable on magnetic resonance imaging, in nine shoulders the tear was smaller than it had been at the time of the initial diagnosis, in nine patients the tear had not changed, and in six patients the tear had increased in size. There was a slight but significant progression of fatty muscle infiltration of the supraspinatus, but no patient had fatty infiltration beyond stage 2 at the time of the latest follow-up (95% confidence interval, 0% to 14%). CONCLUSIONS: In a consecutive series of patients who had been offered repair of an isolated, symptomatic supraspinatus tear, the refusal of operative treatment resulted in surprisingly high clinical patient satisfaction and no increase of the average size of the rotator cuff tear 3.5 years after the recommendation of operative repair. This study confirms that the size of small rotator cuff tears does not invariably increase over a limited period of time. Distinguishing tears that will increase in size from those that will not needs further study.

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Evolution of Nonoperatively Treated Symptomatic Isolated Full-Thickness Supraspinatus Tears

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Background: The natural history of small, symptomatic rotator cuff tears is currently unclear. The purpose of the present study was to assess the clinical and structural outcomes for a consecutive series of patients with symptomatic, isolated full-thickness supraspinatus tears who had been offered rotator cuff repair but declined operative treatment.

Methods: In the study period, twenty-four patients with isolated full-thickness supraspinatus tears that had been diagnosed by means of magnetic resonance arthrography were offered rotator cuff repair and elected nonoperative treatment. The twenty men and four women had an average age of fifty-two years at the time of diagnosis. At a median of forty-two months after the diagnosis, all patients were reexamined clinically according to the Constant and Murley scoring system and all shoulders underwent standard magnetic resonance imaging.

Results: At the time of follow-up, the mean subjective shoulder score was 74% of that for a normal shoulder and the mean Constant score was 75 points (relative Constant score, 86%). The mean rotator cuff tear size did not change significantly over time (95% confidence interval, 0.51 to 1.12). In two shoulders, the tear was no longer detectable on magnetic resonance imaging, in nine shoulders the tear was smaller than it had been at the time of the initial diagnosis, in nine patients the tear had not changed, and in six patients the tear had increased in size. There was a slight but significant progression of fatty muscle infiltration of the supraspinatus, but no patient had fatty infiltration beyond stage 2 at the time of the latest follow-up (95% confidence interval, 0% to 14%).

Conclusions: In a consecutive series of patients who had been offered repair of an isolated, symptomatic supraspinatus tear, the refusal of operative treatment resulted in surprisingly high clinical patient satisfaction and no increase of the average size of the rotator cuff tear 3.5 years after the recommendation of operative repair. This study confirms that the size of small rotator cuff tears does not invariably increase over a limited period of time. Distinguishing tears that will increase in size from those that will not needs further study.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

With increasing age, the rotator cuff undergoes progressive degenerative changes that may lead to tearing of the tendons, with resultant pain and disability. Surgical repair is indicated for patients with symptomatic rotator cuff tears. Repair of single-tendon tears has been highly successful and has yielded durable results that are commonly superior to those obtained without surgery[1-10].

The fear of tear progression is one of the reasons to consider early surgical repair. Once a tear occurs, partial tears can progress to full-thickness tears[11] and full-thickness tears can increase in

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A commentary by Robert Z. Tashjian, MD, is linked to the online version of this article at jbjs.org.

size[12-14]. In addition, successful repair might halt progression of tearing and degradation of the rotator cuff musculature[10,15].

Several authors have recently demonstrated that certain rotator cuff tears progress in size over time, whereas others are unlikely to progress[16,17]. This increases the uncertainty concerning proper informed consent for patients who do not wish to undergo this surgery or who improve clinically while waiting for their scheduled operation.

There is limited information regarding the clinical and structural outcomes for patients with symptomatic isolated full-thickness supraspinatus tendon tears who failed to respond to nonoperative treatment and declined a recommended rotator cuff repair. The purpose of the present study was to analyze the clinical and radiographic outcomes for a consecutive series of such patients. Specifically, we attempted to analyze the progression of rotator cuff tendon tear size and muscle changes seen on follow-up magnetic resonance imaging (MRI) and to correlate the clinical outcome with the imaging findings.

Materials and Methods

All patients with a symptomatic, magnetic resonance arthrography (MR arthrography)-proved, isolated, full-thickness supraspinatus tear for whom operative repair had been recommended and who elected not to undergo surgery between January 2000 to December 2003 were retrospectively selected from the database of our institution.

The inclusion criterion was an isolated, reparable, full-thickness tear of the supraspinatus that was confirmed with MR arthrography in a patient with at least two years of follow-up after declining the recommended surgical repair. A reparable tear was defined as one associated with an acromiohumeral distance of >7 mm on a true anteroposterior radiograph and fatty infiltration of the supraspinatus muscle that was classified as stage 2 or less according to the system of Goutallier[18] as modified for MRI by Fuchs et al.[19].

The exclusion criteria were an age of more than sixty-five years at the time of diagnosis (because the benefit of rotator cuff repair in patients older than sixty-five years of age is controversial), concomitant systemic disease such as a history of diabetes mellitus or rheumatoid arthritis, systemic corticosteroid treatment, and any previous surgery on the involved shoulder.

Thirty-two consecutive patients met the inclusion criteria. Three patients had moved abroad and were unable to report for follow-up examination at our institution. Three patients refused to participate in this retrospective review. One patient had died from unrelated causes. One patient could not be located.

Therefore, our study group consisted of twenty-four patients (twenty men and four women) with a mean age of fifty-two years (range, thirty-nine to sixty-one years) at the time of the initial diagnosis.

In the same time period, 123 patients sixty-five years of age or younger underwent surgical repair of an isolated full-thickness supraspinatus tear at our institution. This group included fifty women and seventy-three men with a mean age of fifty-three years (range, thirty-one to sixty-five years) at the time of surgery. The etiology of the rotator cuff tear was traumatic in fifty-six cases and degenerative in sixty-seven.

The study was approved by the investigational review board of our institution, but only with the use of MRI without arthrography for the follow-up examination.

Imaging

At the time of diagnosis, all twenty-four patients had undergone standardized MR arthrography on a 1.0 or 1.5-Tesla scanner. The follow-up MRI assessment was performed in the same manner as previously reported[20]. At the time of follow-up, all patients underwent MRI without arthrography on a 1.5-Tesla scanner (Siemens, Erlangen, Germany). Continuity or rupture of the tendon was assessed on coronal oblique T2-weighted and proton density-weighted images as well as short tau inversion recovery sequences according to established MRI criteria[21-23].

An experienced musculoskeletal radiologist (C.W.A.P.) who was blinded to clinical data and treatment randomly analyzed the initial MR arthrograms and the follow-up MRIs. The diagnosis of a full-thickness tear was made[23] when there was a fluid-equivalent signal or a visible gap of the supraspinatus tendon in at least one section of the T2-weighted or fat-suppressed sections. The size of the tear was assessed in millimeters in the sagittal and coronal planes with use of the scale available on the examinations on the MR screen. The quality and quantity of the rotator cuff muscles were assessed on parasagittal T1-weighted turbo spin-echo images parallel to the glenohumeral joint[24]. The imaging reached from the muscle insertions at the tuberosities to the medial one-third of the scapula.

Fatty infiltration was assessed as described by Goutallier et al.[18] for computed tomography and adapted by Fuchs et al.[19] for MRI.

Clinical Assessment

Clinical data from the time of diagnosis were collected from the patient charts. Although clinical evaluation was done with a standardized technique, including the use of a handheld goniometer to measure active shoulder motion, a specific shoulder score was not available from these charts.

The clinical follow-up examination was performed in a standardized fashion by two examiners (A.L.V.R., S.F.F.) in the same manner as previously reported[20]. Each patient was evaluated on the basis of a medical history and a physical examination based on the Constant and Murley score[25,26]. This score is based on a scale with a maximum of 100 points. A maximum of 35 points is assigned for subjective variables (pain, activities of daily living, and functional use of the arm); 40 points, for objective assessment of shoulder motion; and 25 points, for quantitative measurement of abduction strength. Active shoulder motion was measured with use of a handheld goniometer with the patient sitting. Shoulder flexion was assessed in the sagittal plane as the angle between the humeral shaft and the midthoracic line. Abduction was always measured with simultaneous maximum abduction of both arms as the angle of the humeral shaft with the midthoracic line. External rotation was assessed according to the method of Constant and Murley[25,26] while the patient performed five functional external rotation movements without touching the head with the hands. Internal rotation was determined on the basis of the spinal process that the patient could reach with the thumb. Abduction strength was measured with the patient standing and the arm abducted to 90° in the scapular plane with the elbow extended and the forearm pronated. The resistance of an Isobex dynamometer (Cursor SA, Bern, Switzerland) was applied to the wrist, and three consecutive measurements with a duration of five seconds each (the B mode of the device) were averaged to measure the strength. One point was assigned per 0.45 kg of strength measured. The strength was only measured in 90° of abduction. If 90° of abduction could not actively be reached, the strength was defined to be zero. The total number of points obtained was related to age and sex-matched normal values as identified by Constant and Murley[25,26]. The respective percentage value was called the relative Constant score[27]. In addition, the subjective shoulder value was assessed[28]. For this value, the patient estimates the value of the affected shoulder as the percentage of an entirely normal shoulder, which is defined to be 100%. At the time of the latest follow-up, the patient was asked to characterize his or her level of satisfaction as very satisfied, satisfied, less satisfied, or not satisfied.

Statistical Methods

A significant deviation from normal distribution was observed, and therefore nonparametric statistics were employed. A post hoc power analysis was considered to be inadequate because of the number of cases and the results. The key issue was the structural evolution of tears. Therefore, the confidence interval (CI) was used. The CI for central tendency of the ratio of tear size after follow-up to baseline was analyzed with use of logarithmically transformed data (log10 [ratio + 0.2]). The CI for proportion (Wilson CI) was used to analyze progression of fatty muscle infiltration.

The Mann-Whitney test was used for unpaired groups, and the Wilcoxon signed-rank test was used for paired groups. The level of significance was set at

TABLE I Personal Data and History

Case	Sex	Age at First MRI *(yr)*	Side	Etiology	Duration of Symptoms to First MRI *(mo)*	Reason Not To Operate	Profession	Working Inability *(%)*
1	M	53	L	Degenerative	4	Accepts symptoms	Bricklayer	100*
2	M	55	L	Traumatic	15	Fear of operation	Roofer	0
3	M	53	L	Traumatic	1	Cessation of symptoms	Mechanic	0
4	M	52	R	Traumatic	6	Relief of symptoms	Warehouse worker	0
5	M	59	R	Traumatic	2	Cessation of symptoms	Teacher	0
6	M	46	R	Traumatic	48	Fear of operation	Floor layer	100
7	M	40	L	Traumatic	4	Relief of symptoms	Computer scientist	0
8	M	44	R	Degenerative	5	Relief of symptoms	Construction worker	0
9	M	52	L	Traumatic	4	Fear of operation	Construction worker	100
10	M	55	R	Traumatic	4	Cessation of symptoms	Logistics coordinator	0
11	F	49	R	Traumatic	3	Cessation of symptoms	Homemaker	0
12	M	57	L	Traumatic	1	Cessation of symptoms	Warehouse worker	0
13	M	52	R	Traumatic	9	Cessation of symptoms	Sports instructor	0
14	M	45	R	Traumatic	1	Relief of symptoms	Construction worker	0
15	F	57	R	Traumatic	3	Relief of symptoms	Secretary	0
16	M	58	R	Traumatic	9	Relief of symptoms	Adjunct	0
17	M	59	R	Traumatic	72	Relief of symptoms	Truck driver	0
18	M	39	R	Traumatic	2	Cessation of symptoms	Architect	0
19	M	47	L	Degenerative	5	No reason given	Warehouse worker	0
20	M	56	L	Traumatic	58	Cessation of symptoms	Construction worker	0
21	F	61	R	Traumatic	11	Relief of symptoms	Crimper	0
22	F	60	L	Degenerative	5	Fear of operation	Homemaker	100
23	M	47	R	Traumatic	1	Relief of symptoms	Economist	0
24	M	53	R	Traumatic	3	Cessation of symptoms	Businessman	0

*The working inability was not caused by the assessed shoulder.

$p < 0.05$. For the relationship between variables, the Spearman correlation coefficient was used.

Source of Funding

This study was funded by departmental funds, which were used to pay the costs for imaging. There was no exterior source of funding that could have played a role in the investigation.

Results

The study group consisted of twenty-four patients (four women and twenty men). The average age at time of diagnosis was fifty-two years (range, thirty-nine to sixty-one years). The patients were reexamined after a median duration of follow-up of forty-two months (range, twenty-seven to eighty-seven months) after diagnosis. The average age at the time of the reexamination was fifty-six years (range, forty-three to sixty-four years). The reasons that surgery was not performed included symptomatic improvement (nine patients), full resolution of symptoms (nine patients), fear of the operation (four patients), and acceptance of the symptoms (one patient). The remaining patient could not give an explanation for his decision.

The median time from the beginning of the symptoms to the first MRI was four months (range, one to fifty-eight months). There were twenty traumatic and four degenerative tears. Initial symptoms reported after trauma were classified as traumatic. Details on the patients are given in Table I.

Imaging

A follow-up MRI examination was performed for all patients. In all twenty-four MRI studies, an extension of the rotator cuff tear into the adjacent infraspinatus (posterior) or subscapularis (anterior) was not seen. Overall, the average tear size did not change significantly over the observation period: it averaged 393 mm^2 at the time of diagnosis and 372 mm^2 at the time of follow-up ($p = 0.53$; 95% CI, 0.51 to 1.12). There also was no significant change in the sagittal (anteroposterior) or coronal (mediolateral) plane extension of the lesion. The average sagittal length was 16 mm (range, 2 to 38 mm) at the time of

Fig. 1-A

Fig. 1-B

Fig. 1-A Coronal MRI view with arthrography, showing a full-thickness tear (arrow) of the supraspinatus at the time of diagnosis. **Fig 1-B** Coronal MRI view without arthrography, demonstrating no change in the supraspinatus tear at the time of the forty-five-month follow-up.

diagnosis and 15 mm (range, 2 to 34 mm) at the time of follow-up ($p = 0.39$), and the average coronal length was 18 mm (range, 2 to 54 mm) at the time of diagnosis and 17 mm (range, 2 to 37 mm) at the time of follow-up ($p = 0.27$). In two patients (Cases 3 and 14), the rupture could no longer be identified at forty-seven and thirty-eight months of follow-up, respectively. The initial MRIs showed small full-thickness lesions with tear sizes of 30 and 25 mm^2, respectively. The follow-up MRIs showed the supraspinatus tendon in continuity without any detectable structural defect with scar or tendon-like tissue bridging the former lesion. In sixteen patients, the size of the lesion remained unchanged or decreased from the time of diagnosis to the time of follow-up. In these patients, the average size was 383 mm^2 at the time of diagnosis and 240 mm^2 at the time of follow-up. In nine shoulders the average decrease of the size of the lesion was 246 mm^2 (range, 51 to 794 mm^2), and in nine shoulders the size of the lesion did not change over time (±30 mm^2) (Figs. 1-A and 1-B). In six patients, the size of the tear progressed, with a mean enlargement of 291 mm^2 (range, 65 to 592 mm^2). In these patients, the average size was 496 mm^2 at the time of diagnosis compared with 787 mm^2 at the time of follow-up. There was no significant difference between the initial size of the tears that decreased in size or remained unchanged and that of the tears that increased in size ($p = 0.23$).

Fatty infiltration of the supraspinatus muscle significantly increased ($p = 0.03$) from the initial MRI evaluation to the follow-up MRI evaluation. At the time of diagnosis, fourteen of the twenty-four patients had stage-0 fatty infiltration and ten had stage-1 fatty infiltration. Ten patients with no fatty infiltration and eight of the ten patients with stage-1 fatty infiltration remained at the same stage at the time of follow-up. In four patients fatty infiltration increased from stage 0 to stage 1, and in two patients it increased from stage 1 to stage 2. No patient had a decrease of fatty infiltration (Table II). No patient had stage-3 or 4 fatty infiltration at the time of follow-up (95% Wilson CI for proportion, 0% to 14%). Larger tears had more fatty infiltration than smaller tears. This was more pronounced at the time of the follow-up MRI evaluation ($p = 0.0001$, $r = 0.77$) than at the time of the initial MRI evaluation ($p = 0.007$, $r = 0.57$). No significant difference could be found between the degree of fatty infiltration of tears that became smaller or remained unchanged and the degree of fatty infiltration of tears that increased in size ($p = 0.23$). Neither tear size nor fatty infiltration at time of diagnosis influenced the structural evolution of the supraspinatus muscle. In the subscapularis and infraspinatus muscles, there was no significant change in fatty infiltration from the time of diagnosis to the time of follow-up. Three patients had stage-1 fatty infiltration of the infraspinatus, and three other patients had stage-1 fatty infiltration of the subscapularis. At the time of follow-up, one patient had stage-2 fatty infiltration (an increase from stage 1), three patients had stage-1 fatty infiltration, and twenty patients had stage-0 fatty infiltration in both the infraspinatus and the subscapularis. Details of MRI parameters are given in Table II.

TABLE II Parameters at First and Second MRI Evaluations*

Case	Duration from Onset of Symptoms to First MRI *(mo)*	Supraspinatus Tear Size† *(mm^2)*		Supraspinatus Fatty Infiltration‡ *(stage)*	
		First MRI	Second MRI	First MRI	Second MRI
1	4	195	108	0	1
2	15	224	196	0	0
3	1	30	0	0	0
4	6	506	418	1	1
5	2	176	768	1	1
6	48	100	120	0	1
7	4	16	16	0	0
8	5	168	63	0	0
9	4	180	96	0	0
10	4	400	500	1	1
11	3	232	256	0	0
12	1	540	1015	1	1
13	9	9	9	0	0
14	1	25	0	0	0
15	3	100	100	1	1
16	9	1088	744	1	1
17	72	324	273	1	2
18	2	342	4	0	0
19	5	870	546	0	1
20	58	1287	1435	1	1
21	11	320	684	0	1
22	5	255	320	1	1
23	1	4	4	0	0
24	3	2052	1258	1	2

*The second MRI was performed forty-two months after the first. †Area measured according to coronal and sagittal tear diameter. ‡Fatty infiltration was classified as stage 1 through 4.

Clinical Results

Subjective Shoulder Score and Constant Score

The average subjective shoulder score was 74% (range, 20% to 100%) of that of a normal shoulder. Seven patients were very satisfied, ten patients were satisfied, five patients were less satisfied, and two patients were not satisfied with the shoulder. The mean absolute Constant score was 75 points (range, 41 to 98 points), and the mean relative Constant score was 86% (range, 31% to 100%). Seven patients had a relative Constant score of 100%. The mean score for pain was 10 points (range, 1 to 15 points) on the visual analog scale. Eight patients were completely pain-free (with the maximum score of 15 points). The average score for the ability to carry out activities of daily living was 8 points (range, 3 to 10 points). Twenty patients had no limitations in the functional use of the arm, whereas four patients had a score of only 8 of 10 points.

At the time of the latest follow-up, the average active flexion was 152° (range, 70° to 170°), the average abduction was 149° (range, 60° to 170°), and the average external rotation was 58° (range, 40° to 80°). The values for active flexion ($p = 0.48$), abduction ($p = 0.22$) and external rotation ($p = 0.14$) did not differ from the time of diagnosis to the time of follow-up. The average abduction strength was 5.6 kg (range, 0 to 10.6 kg). Details of the different clinical parameters at the time of diagnosis and at the time of follow-up are given in Table III.

Working Status

Twenty patients (including one sports instructor, nine sedentary workers, and ten construction workers) worked full time at their regular job. Four patients (including three construction workers and one homemaker) were unable to perform their previous job because of the involved shoulder. All of the four who did not return to their previous work were receiving a disability pension.

Correlation of Imaging and Functional Parameters

There were only weak correlations between the size of the supraspinatus tear at the time of the second MRI evaluation and

TABLE III Clinical Results at Forty-two Months

Case	Flexion *(deg)*	Constant Score* *(%)*	Subjective Shoulder Value† *(%)*	Patient Satisfaction	Abduction Strength‡ *(kg)*
1	140	63	50	Satisfied	2.1
2	140	58	50	Less satisfied	3.7
3	160	100	100	Very satisfied	7.9
4	160	100	70	Satisfied	9.0
5	170	100	100	Very satisfied	6.4
6	120	45	20	Less satisfied	1.9
7	160	93	100	Very satisfied	6.0
8	160	100	90	Very satisfied	10.6
9	70	31	50	Not satisfied	0.0
10	160	94	90	Very satisfied	4.6
11	160	92	70	Very satisfied	2.7
12	150	86	80	Satisfied	5.4
13	160	96	85	Satisfied	9.8
14	160	92	80	Satisfied	8.9
15	160	100	60	Satisfied	4.0
16	160	92	80	Satisfied	4.8
17	120	87	50	Less satisfied	9.4
18	170	100	100	Very satisfied	9.2
19	170	100	90	Satisfied	5.5
20	160	83	70	Less satisfied	5.6
21	160	83	60	Not satisfied	2.3
22	160	74	40	Less satisfied	1.4
23	150	91	90	Satisfied	6.0
24	160	94	98	Satisfied	7.5

*Relative Constant score as a percentage of an age and gender-related normal value. †Patient estimation of the involved shoulder, expressed as a percentage in comparison with an entirely normal shoulder. ‡The values are given as the mean.

pain ($r = -0.17$; $p = -0.44$) and abduction strength ($r = 0.25$; $p = 0.25$). Only weak correlation was also found between the size of the rupture and the subjective shoulder value ($r = -0.14$; $p = 0.14$). The correlation between fatty infiltration of the supraspinatus and abduction strength was also not significant ($r = -0.15$; $p = 0.48$).

At the time of follow-up, the seven asymptomatic patients (Constant score, 15 points) and the seventeen symptomatic patients (Constant score, ≤14 points) were analyzed in terms of progression of the size of the rotator cuff tear. There was no significant decrease or increase in tear size within or between the two groups. The average tear size in the asymptomatic patients was 208 mm^2 (range, 4 to 506 mm^2) at time of diagnosis and 222 mm^2 (range, 0 to 768 mm^2; $p = 0.75$) at the time of follow-up, whereas the average tear size in the symptomatic group was 488 mm^2 (range, 9 to 2052 mm^2) at the time of diagnosis and 448 mm^2 (range, 0 to 1435 mm^2) at the time of follow-up ($p = 0.55$). There was no significant difference between the asymptomatic group and the symptomatic group in terms of average tear size progression from the first MRI to the second MRI (14 mm^2 [range, −338 to 592 mm^2] compared with 40 mm^2 [range, −794 to 475 mm^2]; $p = 0.85$). There was also no significant difference between the two groups in terms of tear size at time of diagnosis (313 compared with 427 mm^2; $p = 0.25$) or at the time of follow-up (271 compared with 414 mm^2; $p = 0.13$).

Discussion

The present study demonstrated that isolated full-thickness supraspinatus tears in patients under the age of sixty-five years did not necessarily increase in size over a mean follow-up period of 3.5 years. Although the size of the tear increased in 25% of the shoulders, the mean size was not significantly different. In contrast, we did find a significant increase in fatty infiltration of the supraspinatus muscle, although no patient had infiltration beyond Goutallier stage 2. The structural evolution of smaller rotator cuff tears has not been well studied. It is commonly accepted that once a tear occurs, it tends to progress over time[11-14]. Concern about tear progression and progressive fatty infiltration that could cause shoulder disability as well as render

the lesion irreparable are important considerations that lead some surgeons to favor early repair.

The present study had limitations. First, different imaging modalities (MR arthrography at the time of diagnosis and MRI without arthrography at the time of the latest follow-up) were used. This might partially account for the different tear sizes at the time of follow-up as well as the finding that some tears appeared to be smaller at the time of follow-up. The literature suggests that, for the identification of full-thickness tears, standard MRI shows no difference from MR arthrography[29]. For that reason, and because the patients in the present series were in part asymptomatic, our investigational review board did not permit repeat arthrography at the time of follow-up MRI. We were also interested in the progression of fatty infiltration of the rotator cuff musculature, for which the two examinations are considered equivalent. A second limitation is that the number of patients was small as a result of our strict inclusion criteria (no previous surgery on the involved shoulder, MRI at the time of diagnosis, reparable tears according to established MRI and radiographic criteria, and recommended and declined operative treatment), resulting in a very selected group of patients.

Our findings are in contrast with other accepted opinions that all rotator cuff tears are at risk for progression over time[11-14]. Similar to our findings, Yamanaka and Matsumoto[11] documented with sequential shoulder arthrography studies that partial rotator cuff tears became smaller or disappeared in eight of their twenty patients. Our findings also agree with the results of a recent study by Maman et al.[17], who also observed a decrease in tear size in 9% of the cases. They found that four of the five cases in which there was a decrease in tear size were in patients with isolated full-thickness supraspinatus tears. We observed not only decreases in tear size but also disappearance of the tear in 8% of the patients, suggesting bridging of the defect with scar or tendon-like tissue. This seems to confirm the finding that small rotator cuff defects (<400 mm^2) might have a potential to close, as previously reported in a series of reruptures after open rotator cuff repair[16].

Whereas small isolated supraspinatus tears may not necessarily enlarge over time, this seems not to be true for large massive tears involving more than two complete tendons. In a recent report, Zingg et al.[30] documented that the size of nonoperatively treated massive rotator cuff tears significantly progressed over time. The same tendency was also observed by Maman et al.[17].

In the present study, the supraspinatus tears did not show any relevant further structural alterations in terms of fatty infiltration of the muscle. Although there was a progression of fatty infiltration, twenty-two of the twenty-four patients had no more than stage-1 infiltration at the time of follow-up. Furthermore, no supraspinatus muscle had fatty infiltration that was beyond stage 2, meaning that all of the tears were still reparable. This finding is in contrast to the finding reported by Zingg et al. that 50% of nonoperatively treated massive rotator cuff tears that were initially reparable had become irreparable within four years[30].

Therefore, although immediate repair of a symptomatic reparable, isolated supraspinatus tear may be preferred by some, the results of the present study question whether this approach is always appropriate or necessary. In our cohort of patients, the clinical results without operative treatment were almost as good as those reported by others after operative rotator cuff repair, with about 80% of the patients reporting good to excellent clinical results and return to full-duty work activities. Furthermore, our findings do not answer the question about whether yearly surveillance or monitoring of such shoulders to identify tear size progression should be recommended[14]. The clinical relevance of the slight progression of fatty infiltration over time cannot yet be determined with the data from the present study. It is uncontested, however, that progression of fatty infiltration can best be halted (but not reversed) after successful repair of isolated supraspinatus tears[10].

In conclusion, small isolated full-thickness tears of the supraspinatus in patients under the age of sixty-five years do not necessarily progress over time. Although early repair of isolated tears may be preferred by some, a delay of surgery does not necessarily affect tear reparability. Future research should be directed at determining which tears progress and which tears do not as well as the clinical relevance of rotator cuff tear progression. ■

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